AMENDMENTS TO THE SPECIFICATION

On page 1, after the Title, insert:

Cross-Reference To Related Applications

This application is a Continuation of Application Serial No. 10/369,055, filed March 25, 2003.

On page 3, lines 20-26, please replace the original paragraph with the following amended paragraph:

There is a need, therefore, to improve the reaction time of electromagnetic field presence sensors, to reduce the potential for false actuation of these sensors, and more particularly, for these sensors to reliably differentiate between bare or gloved hands and foreign objects. A particular need exists for these sensors and switches that exhibit reduced noise sensitivity, particularly to periodic or cyclic noise. Furthermore, there is a need for such sensors and switches capable of self-calibrating and [[detect]] detecting when conditions are outside normal operating ranges.

On page 4, lines 2-28, please replace the original three paragraphs with the following three amended paragraphs:

The present invention provides a novel technique and apparatus, with improved noise immunity, for reliably detecting the presence or absence of an object, such as for switching purposes, designed to respond to such needs. The technique makes use of varying or random sample periods [[so]] to overcome sensitivity to periodic or cyclic noise. The technique thus results in reduced sensitivity to noise patterns that can correspond with sample intervals between sample acquisition times. Moreover, the technique offers novel tools for analyzing sampled data from a sensor that can serve as the basis for identifying the presence or absence of an actuating object, potential fault or malfunction of the device, or a level of noise judged too elevated to permit reliable signal output or switching.

In accordance with one aspect of the present technique, a method is provided for controlling a switching circuit. In accordance with the method, signals are measured from a sensor in response to an actuating object. The measured ~~sensors~~ signals are randomly sampled. The state of an output signal is then changed based upon the randomly sampled measured signals. The measurement may include converting the sampled signals to digital values, and the digital values may be accumulated and compared to a threshold value to determine the appropriate state of the output signal. The measured signals may be in response to a strobe signal, with the strobe signal being applied at random intervals to render a greater immunity to cyclic or periodic noise.

In accordance with another aspect of the technique, a system is ~~providing~~ provided for controlling a switching circuit that includes generating signals from a plurality of sensors in response to an actuating object and a strobe signal applied to the sensors at random intervals. The generating signals are then sampled. The state of an output signal is changed based upon the sample signals from the plurality of sensors. A noise-responsive measurement may be taken as well to determine a relative noise level based upon the noise-responsive signals.

On page 7, lines 12-24, please replace the original paragraph with the following amended paragraph:

Various types and forms of output signals may be generated by the sensor. For example, simple varying voltage or current waveforms may be produced, indicative of the influence of an actuating object on the sensor, such as by coupling. The output may alternatively be a binary presence signal, or a variety of both binary and analog type presence outputs. The output may be an analog output indicating, for example, a distance to a remote object as deduced by the amount of energy transfer. Similarly, the output may take the form of a simple digital signal or may be a more complex network compatible message for communication on standard industrial networks. In the illustrative embodiment of Figure 1 and as described in greater detail below, two electrode pads 14 and 16 may be

included, such as in the form of individual metallic or conductive elements, that provide redundant or complementary output signals indicative of more than one field interaction effect with an actuating object, both effects serving as a basis for evaluating the noise level of the system and the appropriate state of the output signal produced.

On page 7, lines 26-29, through page 8, lines 1-9, please replace the original paragraph with the following amended paragraph:

Referring now to Figure 2, signal generating and sensing circuits 24 are schematically illustrated. The signal generating circuit may include one or more electrode pads (two such pads 14 and 16 being provided in the illustrated embodiment), and one or more strobe circuits 32a and 32b (pulse generators) used to excite the electrode pads 14 and 16 with an input signal, such as a voltage signal. The housing 12 (Figure 1) holds a sensing circuit that may include one or more operational amplifiers 28a and 28b, or similarly operating devices, and one or more resistors 30a and 30b. The amplifiers 28a and 28b serve to measure the change in voltage (and thus current flow) across resistors 30a and 30b. Amplifiers 28a and 28b compare the resistor terminal voltages at points 34a and [[36b]] <u>36a</u>, and points 34b and 36b. A processing circuit is then used to analyze the measured current. It is noted that other sensing systems can be easily substituted, including other current sensing devices or voltage sensors, and the actuating signals detected may result from various physical or electrical phenomena, such as changes in capacitive or inductive coupling.

On page 9, lines 15-29, please replace the original paragraph with the following amended paragraph:

As will be appreciated by those skilled in the art, noise may be introduced from a variety of sources such as the environment, for example, by capacitive or inductive coupling with leads or points in the circuitry, or conducted through the power line provided to the sensing circuitry. The presence of noise may cause perturbations in voltage levels, additional current flow through the electrode pads 14 and 16, and

ultimately cause unwanted false actuation or non-actuation of the presence sensor 10 and associated switches. The present technique addresses many such situations, particularly those in which the noise source may be periodic or cyclic in nature, and have a period which coincides with (i.e. is a multiple or factor of) the timing of the strobe circuits 32a and 32b ~~inputs~~ used to excite the pads 14 and 16 with a voltage for sampling (to detect the presence or absence of an object near or touching sensing surface 18). Thus, the noise may become a component of the sample current readings and may falsely indicate that an object is touching or near the sensing surface 18 when such is not the case, or vice versa. Accordingly, as described below, the strobe input timing is randomized, so that the sensing circuitry may efficiently account for or avoid the effects of such noise.

On page 10, lines 1-23, please replace the original paragraph with the following amended paragraph:

Referring now to Figure 3, the strobe and response waveforms 40 are illustrated. In particular, the strobe input pulse 42 and current response 44 versus time are represented, and sample acquisition times at four points (reference point 46, on peak point 50, reference point 48 and off peak point 52) are noted. The peak of this current response is considered directly proportional to capacitance of the generating circuit. In one embodiment, four analog-to-digital converters are used to measure the response to the strobe input. Figure 3 shows the sequence (time) locations of the four measurements at reference point 46, on peak point 50, reference point 48 and off peak point 52. The ~~difference~~ differences in current between the on peak measurement point 50 and reference point 46 is designated as the on sample value 54, while the difference in current between the off peak measurement point 52 and reference point 48 is designated as the off sample value 56. In normal operation, the magnitude of the current at the on peak 50 will be higher for higher degrees of capacitance coupling. Points 46 and 48 are measured just before the leading and trailing edges, respectively, of the strobe input pulse 42, and are used as noise-indicating values, as described below. To render the system more immune to electrical noise, the difference between consecutive on sample values 54 and off

sample values 56 are accumulated for a large number of strobe input pulses. In a present embodiment, a value is thus computed, called "~~Accumulate~~ Accumulated Differences" and the resulting value is in a variable named accDif, which is a measure of the sum of the noise plus the current response to the presence and absence of an object near or touching the sensing surface 18 (Figure 1). As will be appreciated by those skilled in the art, actual measurements and signal processing are based upon digitized values for the measurements at points 46, 48, 50 and 52 over an available dynamic range, such as 0-255.

On page 13, lines 15-29, please replace the original paragraph with the following amended paragraph:

In the absence of any noise, the value of measurements taken at points 46 and 48 would be near the middle of the dynamic range. However, noise causes them to vary from the midpoint. The total of the many readings of the absolute difference between measurements taken at points 46 and 48 and the actual value of the dynamic range midpoint is, in a present embodiment, called "Accumulated Absolute" (accAbs). A threshold of the accAbs value, then, may be used to provide a relative indication of the degree of noise experienced by the sytem. While a set threshold may be employed, such thresholds may not provide the desired degree of confidence due to changes in the amplitude and frequency of the noise and the coupling capacitance. Thus in a present implementation, a ratio threshold value is employed, such as the ratio of the accAbs to the pad-to-earth accDif (PE). Because noise primarily couples through the same capacitance that ~~the that~~ serves as the basis for pad-to-earth measurements, the ratio of the accAbs and the pad-to-earth accDif (PE) tends to cancel the capacitance effect. The actual threshold employed for this noise characterization may vary, depending upon the system design, and taking into account any unknown capacitance effects.

On page 14, lines 15-20, please replace the original paragraph with the following amended paragraph:

In one embodiment, the presence sensor 10 performs certain logical steps based upon sampled data values to determine whether the system noise is such that reliable actuation is possible, and whether sampled signals correspond to scenarios defined for changes of state (i.e. switching on or off output signals). Referring now to Figure 6, the presence sensor 10 state diagram 86 shows various logical states and transition logic for movement between the states.

On page 15, lines 28-29 through page 16, lines 1-8, please replace the original paragraph with the following amended paragraph:

The operation will move from the CHECK_NOISE state [[88]] 90 to a NOISY state 94 if the noise readings exceed a predetermined threshold, and ultimately move to the original UNTOUCH state 112 if the IPE, QPE, and the two accumulated pad-to-pad readings all fall within the UT ranges. The two accumulated pad-to-pad readings are represented by IPP (excite the second pad 16 "Q" and read capacitance of the first pad 14 "I") and by QPP (excite the first pad 14 "I" and read capacitance of the second pad 16 "Q"). In the present implementation, the circuitry successively excites (i.e. applies the strobe input) to one pad and then to the other to make the desired measurements, with the baseline measurements made at points 46 and 48 being made before and after each input pulse.

On page 16, lines 10-19, please replace the original paragraph with the following amended paragraph:

If, at the CHECK_NOISE state 90, the noise readings are lower than a predetermined threshold, the operation will move to the QPE_ON state 96. From this point, the operation may progress to the IPP_ON state 98 if the IPP ~~values~~ value exceeds a predetermined threshold, and then on to the RELAY_ON state 102 if the QPP value

exceeds a predetermined threshold. It is noted that if the IPP or QPP values do not exceed their respective threshold values, the operation will move to the FAULT state 100 (indicating, for example, that the sensed object 20 as illustrated in Figures 1 and 2 may be a foreign object and not the anticipated actuating object, e.g. a human hand), and then possibly move from the FAULT state [[10]] <u>100</u> to the original UNTOUCH state 112 as discussed above.

On page 17, lines 4-13, please replace the original paragraph with the following amended paragraph:

In one embodiment, the presence sensor 10 reads the capacitance by measuring current flow to the electrode pads 14 and 16 (Figures 1 and 2) while providing the strobed input or excitation signal. As discussed above, the signals are preferably provided for sampling at random intervals to afford immunity to periodic or cyclic noise. The timing of this measurement is determined, for example, by the execution of assembly programming code within a digital signal processor (DSP) of a type well known in the art. In one implementation, the low level code for data acquisition is broken up into two routines: StrobeOnRead and StrobeOffRead. The execution timing is maintained fixed despite any changes in the code due to the fact that the code is neither interrupt driven [[or]] <u>nor</u> polled.

On page 17, line 21-28, please replace the original paragraph with the following amended paragraph:

For the strobe turn on 116, two reading are taken. One just prior to any change caused by the strobe [[122]] <u>126</u>, for example, at point 128 (read point 46 as illustrated in Figure 3), and another close to the peak of the response, for example, at point 130. The DSP assembly code for the StrobeOnRead follows. First the A/D converter is set to acquire the prestrobe value at point 128. While the sample is being converted, it calculates the absolute difference between point 128 and a previously measured bias for

the "Accumulate Absolute" function. Finally the peak value at point 130 is read, and the new "on" sample is computed.

On page 18, line 1-8, please replace the original paragraph with the following amended paragraph:

For the strobe turn off 118, two ~~reading~~ <u>readings</u> also are taken. One measurement is taken just prior to any change caused by the strobe 122, for example, at point 132 (read point 48 as illustrated in Figure 3), and another close to the peak of the response at point [[132]] <u>134</u>. The DSP assembly code for the StrobeOffRead follows. First, the A/D converter is set to acquire the prestrobe value at point 132. While the sample is being converted, the difference is calculated between the measurement at point 132 and a previously measured bias for the "Accumulate Absolute" function. Finally, the peak value at point 132 is read, and the new "off" sample is computed.

On page 26, lines 2-12, please replace the Abstract of the Disclosure with the following amended Abstract of the Disclosure:

A technique for controlling a switching circuit[[, such as a relay,]] includes one or more sensing circuits that generate signals based upon the presence of an actuating object and upon a randomly applied strobe signal. The generated signals are sampled and are used as a [[basis]] for determining the state of an output signal. The sensing circuit may generate the signals based upon capacitive coupling with the actuating object. The randomization of the sampling ~~provides enhanced~~ <u>enhances</u> immunity to periodic ~~or cyclic~~ noise. Where more than one sensing circuit is included, the output of the circuits may be considered together for determining the state of the output signal, such as based upon predetermined ranges of signal levels. Signals of the sensing circuit may be sampled in the absence of the strobe to provide an indication of the relative noise level. If the noise level is determined to be elevated, the output signal may not change states.